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NATIONAL DAM SAFETY PROGRAM. LAKE PRIMROSE DAM (MO 30904), UPPE--ETC(U)
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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		



DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

3 August 1979

ERRATA

The following page is a revised SECTION 7 for the Lake Primrose Dam report. It contains information not previously included in that section and should be used in lieu of page 10 of this report.

SIGNED

JACK R. NIEMI
Chief, Engineering Division

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SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Corrective measures should be taken for the deficiencies visually observed by the inspection team, i.e., seepage, erosion, and growth of trees on the embankment and in the spillway outlet channel. Inadequate spillway capacity is also a deficiency which should be corrected.

b. Adequacy of Information. No engineering design and construction data was available and the conclusions of this report are based on performance and external visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the Recommended Guidelines (including seismic analyses) were not available and this is considered a deficiency which should be rectified.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The item recommended in paragraph 7.2.a should be pursued on a high priority basis.

d. Necessity for Phase II. Based on the result of the Phase I inspection, no Phase II inspection is recommended.

7.2 REMEDIAL MEASURES

a. Alternatives. The spillway will pass only 25 percent of the probable maximum flood without overtopping. The spillway capacity and/or height of dam should be increased to pass the probable maximum flood.

b. O&M Procedures. The following O&M procedures are recommended:

(1) Trees and excessive vegetation should be removed from the downstream slope and spillway outlet channel.

(2) Seepage should be monitored to determine the quantity of flow and sedimentation and it is recommended that corrective measures be designed by an experienced professional engineer based on appropriate analyses.

(3) Up-to-date records of all future maintenance and repairs should be kept.

(4) The dam should be periodically inspected by an engineer experienced in the design and construction of dams.

LAKE PRIMROSE DAM

ST. FRANCOIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30904

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY

Kenneth Balk & Associates, Inc.
St. Louis, Missouri
Shannon & Wilson, Inc.
St. Louis, Missouri

PREPARED FOR

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

SEPTEMBER, 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lake Primrose
State Located	Missouri
County Located	St. Francois County
Stream	Primrose Creek
Date of Inspection	August 3, 1978

Lake Primrose Dam, No. 30904 was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U. S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Lake Primrose Dam was visually inspected by an interdisciplinary team of engineers from Kenneth Balk & Associates, Inc. and Shannon & Wilson, Inc. The purpose of the inspection was to make a preliminary assessment of the general condition of the dam with respect to safety in order to determine if, in the opinion of the interdisciplinary team, the dam poses recognizable hazards to human life or property. This assessment is based solely upon data made available and visual evidence observed during the site visit.

To make a complete assessment of the safety of the dam would require detailed studies and engineering analyses beyond the scope of this preliminary assessment.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends six miles downstream of the dam. Within the damage zone are three homes, a mobile home, one church, one State highway crossing, and one improved road crossing. There is some farming in the floodplain. Lake Primrose Dam is in the intermediate size classification since it is greater than 40 feet high but less than 100 feet high.

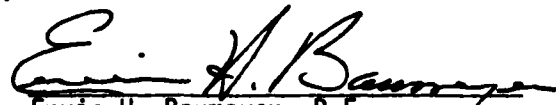
The inspection and evaluation indicate that the spillway of Lake Primrose does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Lake Primrose is an intermediate size dam with a high hazard potential, required by the guidelines to pass the PMF. Considering the high hazard potential to loss of life and property downstream of the dam, the outlet facilities of Lake Primrose Dam should be able to pass the PMF without overtopping the dam. However, it was determined that the spillway will only pass approximately 25 percent of the PMF without overtopping the dam.


Since the outlet facilities for Lake Primrose are not capable of passing the PMF without overtopping the dam, the spillway is considered inadequate and the dam is accordingly classified as an unsafe, nonemergency structure.

The evaluation of Lake Primrose also indicated that the spillway will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

Deficiencies visually observed by the inspection team were seepage, erosion, a very thick cover of grass, small trees on the downstream slope, and a few small trees in the spillway outlet channel. Other deficiencies found were the lack of seepage records, operational records, seepage and stability analyses comparable to the requirements of the Recommended Guidelines, and seismic stability analyses.

It is recommended that action be taken in the near future to correct or control the deficiencies described. A detailed report discussing each of these deficiencies is attached.


Ervin H. Baumeyer, P.E.
Principal-In-Charge
Kenneth Balk and Associates, Inc.
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Principal Engineer
Shannon & Wilson, Inc.
St. Louis, Missouri

SIGNED

SUBMITTED BY:

Chief, Engineering Division

26 MAR 1979

Date

APPROVED BY:

Colonel, CE, District Engineer

27 MAR 1979

Date



Overview of Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE PRIMROSE DAM - ID NO. 30904

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lake Primrose Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon data made available and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure built on Primrose Creek in the northern part of St. Francois County, Missouri. Topography adjacent to the valley is rolling to steep. Most of the area in the vicinity of the dam is covered with a residual soil overlaying dolomite. Topography in the vicinity of the dam is shown on Plate 1.

(2) The spillway consists of a 10' diameter CMP, apparently deformed (actual measurements 11' x 9'). The conduit is preceded by a concrete paved approach channel laid on an approximate slope of 21%.

(3) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the northwestern portion of St. Francois County, Missouri, as shown on Plate 2. The lake formed by the dam is on the Missouri-St. Francois County Bonne Terre quadrangle sheet in the SW 1/4 Section 23, T38N, R4E. Nearest downstream City is Blackwell.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the intermediate size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c above. Based on referenced guidelines, this dam is in the High Hazard Classification.

e. Ownership. This dam is owned by American Triad Corporation, 2006 Truman Boulevard, Crystal City, Missouri 63019.

f. Purpose of Dam. The dam forms a recreational lake.

g. Design and Construction History: There are no known design plans or construction records.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and spillway discharge all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 545 acres.

b. Discharge at Damsite.

(1) Pipe spillway - 621.6 cfs. at maximum pool.

(2) Estimated experienced maximum flood - approximately two feet below top of dam.

c. Elevation (U.S.G.S.)

(1) Top of dam - 808.5.

(2) Invert of pipe spillway - 798.8.

(3) Invert of concrete approach channel - 803.

(4) Spillway Crest - Pipe 798.8, approach channel - 803.

(5) Streambed at Centerline of Dam - 755.

(6) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 2500 feet \pm .

e. Storage (Acre-feet).

(1) Normal - 418

(2) Maximum - 607.5

f. Reservoir Surface (Acres).

- (1) Top of dam - 39.
- (2) Spillway crest - 30.

g. Dam.

- (1) Type - earth embankment.
- (2) Length - 700 feet.
- (3) Height - 53 feet maximum.
- (4) Top width - 25 feet.
- (5) Side Slopes - (Measured by Brunton Compass in degrees and converted to ratios.)
 - (a) Downstream upper ten feet - 1.5 H. to 1 V., remainder to toe; 2 H. to 1 V.
 - (b) Upstream - 2 H. to 1 V. to waterline.

- (6) Zoning - unknown
- (7) Impervious core - unknown
- (8) Cutoff - unknown
- (9) Grout curtain - unknown

h. Diversion and Regulating Tunnel. None.

i. Principal Spillway.

- (1) Type - Deformed 10' diameter CMP with paved concrete approach channel laid on an approximate slope of 21%.
- (2) Crest elevation pipe - 798.8, channel - 803.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were found to be readily available.

2.2 CONSTRUCTION

According to information supplied by the Corps of Engineers, the dam was completed in 1971. No other information was available.

2.3 OPERATION

No records of the maximum loading on the dam were available.

2.4 EVALUATION

a. Availability. No engineering or geological data were readily available.

b. Adequacy. No engineering data was made available to make a detailed assessment of the design, construction, and operation. The lack of seepage and stability analyses comparable to the requirements of the Recommended Guidelines is considered a deficiency which should be corrected. An engineer experienced in the design of dams should be retained to perform detailed seepage and stability analyses for appropriate loading conditions (including earthquake loads) and the results made a matter of record.

c. Validity. No valid engineering data on design were available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General. A visual inspection of the Lake Primrose Dam was carried out on August 3, 1978. Personnel making the inspection were employees of Kenneth Balk and Associates, Inc. and Shannon and Wilson, Inc. of St. Louis and included civil, geotechnical, and structural engineers and an engineering geologist. Specific observations are discussed below.

B. Dam. The inspection team observed the following at the dam. The dam is an earth structure with a gravel road running across the crest. The slope of the right abutment is much flatter than the left abutment slope with the consequences that the toe of the dam is located approximately 1/3 of the distance from left abutment (measured along the crest). There was no visual evidence that the dam was keyed into the abutments. The upper 10 feet of the downstream slope is steeper than the remainder of the slope (see section 1.3.g.5(a)). No detrimental settlement, depressions, cracking, animal burrows or slope instability were observed on or near the embankment.

Seepage was observed at the toe and the juncture of both abutments and was estimated to be 5 to 10 gallons per minute. The lower portion of the downstream slope was soft and marshy in spots and cattails, brush and some small trees were growing on the slope. Some surface erosion was evident on the right abutment.

Gravel and cobbles were observed on the upstream slope at the waterline and a grass cover for the remainder of the slope as wave erosion protection.

C. Appurtenant Structures. The spillway is of the conduit type placed on the right abutment. The conduit is apparently a 10 foot diameter corrugated metal pipe which has deformed to oval shape. Actual measured dimensions are 11' x 9' with a length of 40 feet. The conduit is preceded by a paved concrete approach channel laid on an approximate slope of 21%. The outlet channel is lined with a sand cement grout for approximately 75 feet. At the end of the lined section, the outlet channel drops 5 feet to the unlined channel cut into residual soil. The unlined portion of the channel is eroding and the lined section is being undercut with the grout breaking up in sections.

D. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shore of the reservoir.

E. Dam Site Geology.

Left Abutment: Left abutment is covered with a thick blanket of red, silty clay. At places quartz druse were present, suggesting an underlying bedrock of the Potosi Formation which mainly consists of dolomite. No outcrop is visible on the left abutment.

Right Abutment: No bedrock is exposed on the right abutment. The area around dam and right abutment is covered with a thick layer of silty clay.

Spillway: About 500 feet downstream a small outcrop is exposed in the erosion channel below the spillway. This outcrop exposes a gray, massive, compact, moderately weathered, moderately jointed dolomite overlain by two to three feet of quartz druse. Quartz druse is overlain by six to nine feet thick bed of silty clay. Due to the small size of the outcrops, dip-strike or other observations of joints could not be accomplished. Numerous small, well developed quartz crystal are present in the wash material at the base of creek, the source of which is quartz druse.

3.2 EVALUATION

The seepage observed is of such quantity and areal extent that, in our opinion, it is considered through-seepage and an engineer, experienced in the design and construction of dams, should be retained to perform a steady state seepage analysis and design appropriate measures to control or eliminate the deficiency. The excessive vegetation, i.e. brush and small trees should be removed from the embankment slopes. The lower section of the spillway outlet channel will continue to erode deeper into the abutment and undermine the lined section under sustained discharges. The continued erosion in the outlet channel may eventually affect the integrity of the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating structure exists at this dam. The lake level is affected by rainfall, runoff, evaporation, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

No maintenance records of the dam were available. The amount and size of the vegetation on the embankment suggest that maintenance, if any, has not been regular.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

In our opinion, a regular program of vegetation control and maintenance should be initiated. The trees and brush on the dam are deficiencies which should be corrected.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There were no hydraulic and hydrological design data made available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Bonne Terre, Mo. Quadrangle. The spillway and dam layout are from surveys made during the inspection.

c. Visual Observations. The spillway approach channel and conduit outlet channel, except as noted in Section 3, are in good condition. With the exception of apparent deformation, the pipe spillway is in good condition. Spillway discharges, as noted in Section 3, may eventually endanger the integrity of the dam.

d. Overtopping Potential. The spillway has been found to be inadequate to pass the Probable Maximum Flood (PMF) without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

For the PMF, the dam would be overtopped to a maximum height of approximately 2.6 feet with a duration of overtopping of approximately 6 hours and a maximum discharge rate of 5133 cfs. In our opinion, failure of the dam may be expected to occur as a result of overtopping for this length of time.

The spillway has been found to be adequate to pass a flood of approximately twenty-five percent (25%) of the PMF.

The spillway has been found to be adequate to pass the 100-year flood, which has a 1% chance of being equalled or exceeded at least once during any given year.

The estimated damage zone extends six miles downstream of the dam. Within the damage zone are three homes, a mobile home, one church, one State highway crossing, and one improved road crossing. There is some farming in the floodplain.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visually observed conditions which can affect the structural stability of this dam have been discussed in Section 3.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam were found except that discussed in Section 1.2.

c. Operating Records. No appurtenant structures requiring operation exist at the dam, therefore, no records exist.

d. Post-Construction Changes. No post-construction changes are known or apparent.

e. Seismic Stability. Lake Primrose Dam is located in Seismic Zone 2. Since no engineering design data was available, an evaluation of the seismic stability of the dam could not be made and the effect of an earthquake of the magnitude expected in this zone on a dam of this type and size could not be assessed.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Corrective measures should be taken for the deficiencies visually observed by the inspection team, i.e. seepage, erosion, and growth of trees on the embankment and in the spillway outlet channel. Inadequate spillway capacity is also a deficiency which should be corrected.

b. Adequacy of Information. No engineering design and construction data was available and the conclusions of this report are based on performance and external visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the Recommended Guidelines (including seismic analyses) were not available and this is considered a deficiency which should be rectified.

7.2 REMEDIAL MEASURES

a. O&M Procedures. The following O&M procedures are recommended:

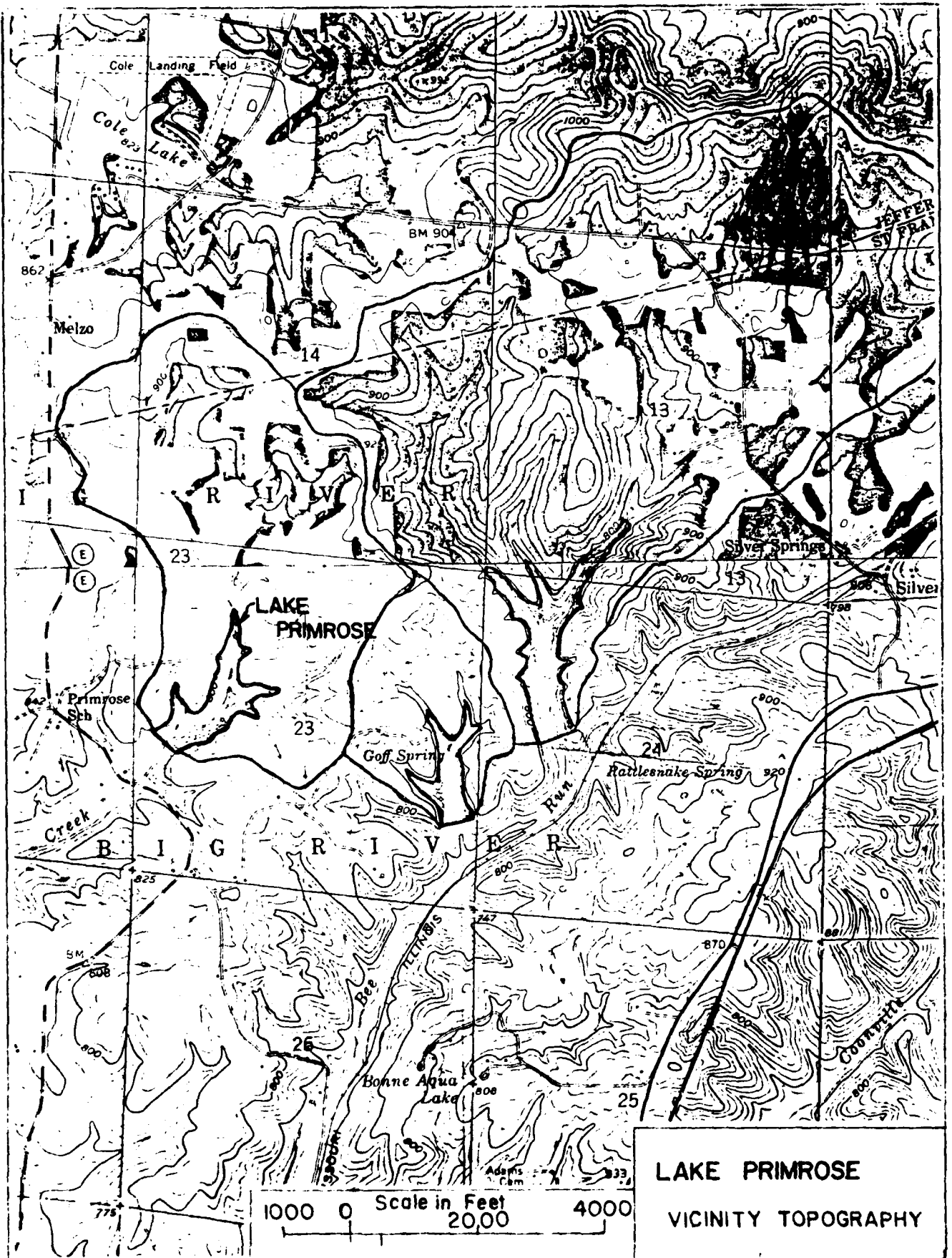
(1) Trees and excessive vegetation should be removed from the downstream slope and spillway outlet channel.

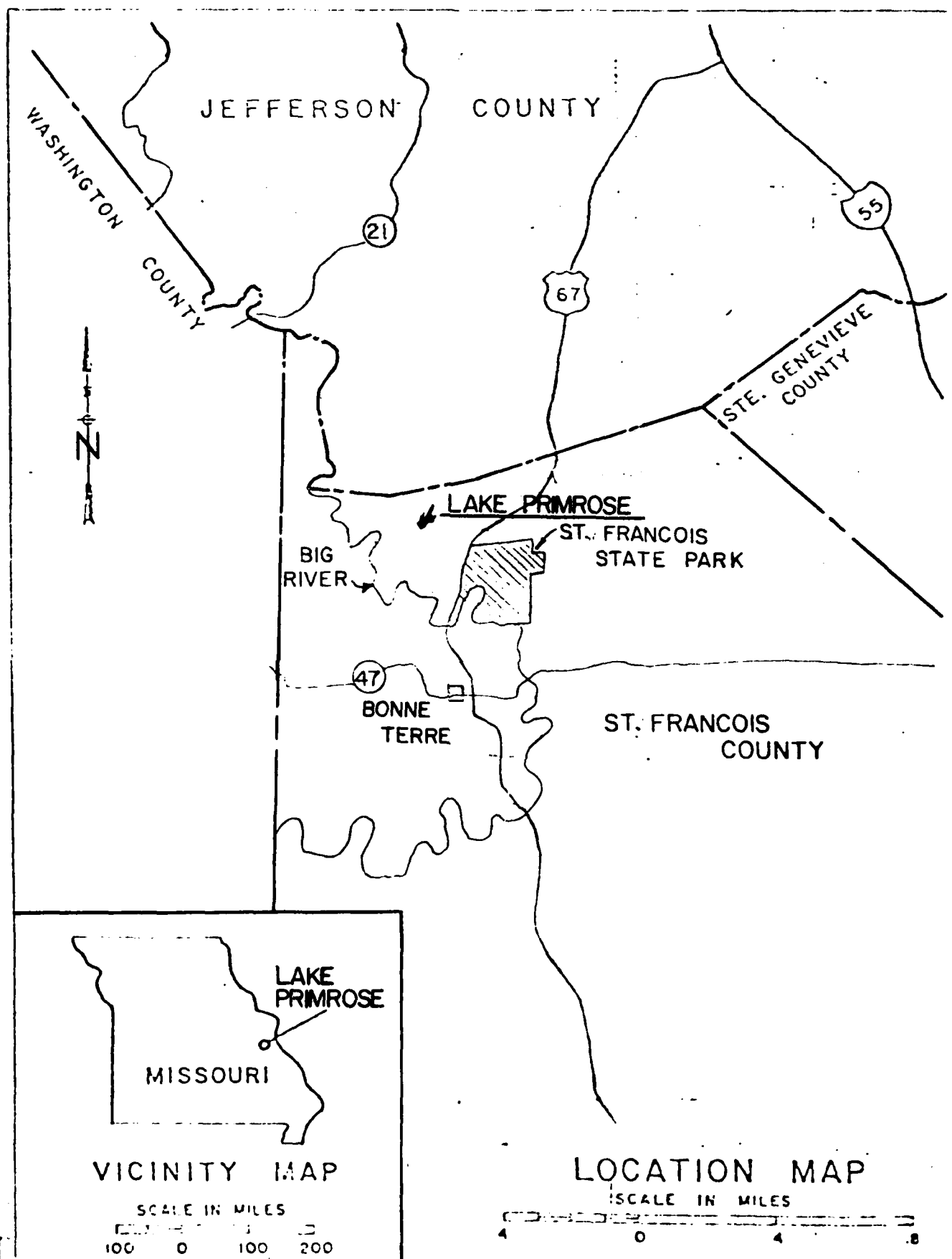
(2) Seepage should be monitored to determine the quantity of flow and sedimentation and it is recommended that corrective measures be designed by an experienced professional engineer based on appropriate analyses.

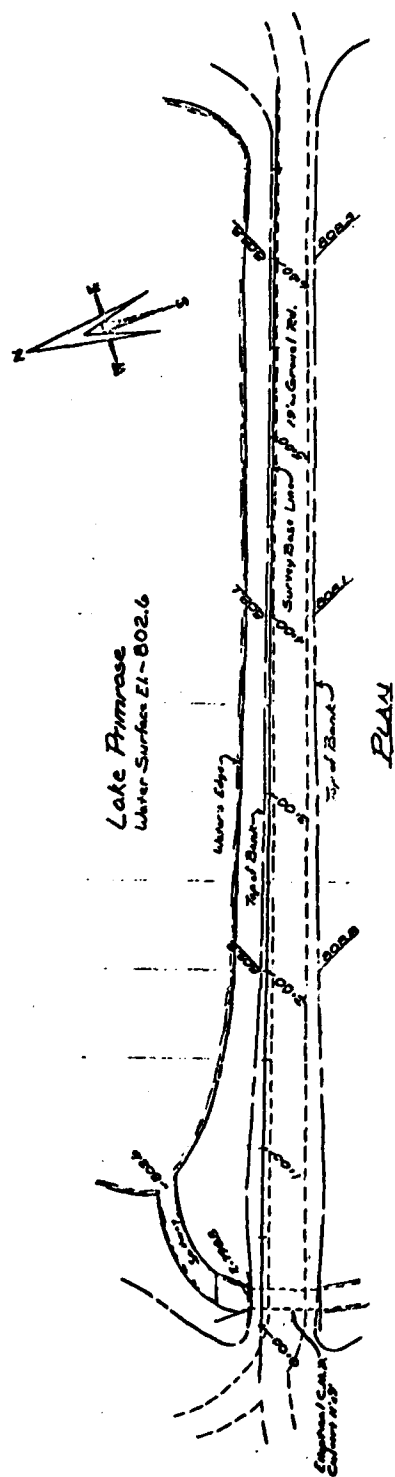
(3) Up-to-date records of all future maintenance and repairs should be kept.

(4) Spillway capacity and/or height of dam should be increased to pass 100 percent (100%) of the Probable Maximum Flood.

(5) The dam should be periodically inspected by an engineer experienced in the design and construction of dams.





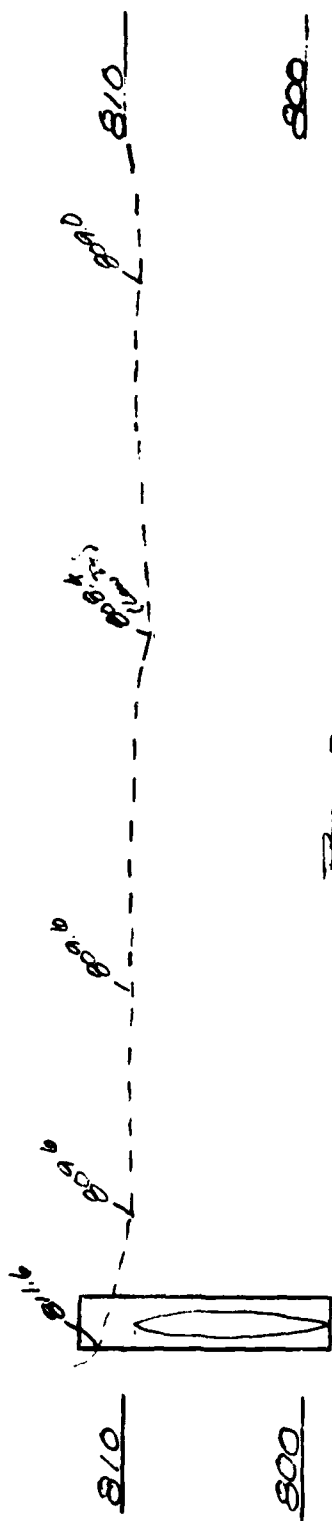


LAKE PRIMROSE

TOP OF DAM
ELEVATIONS

SCALE: 1"=100'

PLATE 3



PROFILE
 SCALE: 1" = 10' HORIZ.
 1" = 10' VERT.

TYPICAL CROSS SECTION
 SCALE: 1" = 20' HORIZ. & VERT.

LAKE PRIMROSE
 DAM PROFILE
 and CROSS SECTION



PHOTO 1: Overview of Lake and Dam.



PHOTO 2: Crest of Dam.



PHOTO 3: Spillway Entrance Looking Downstream.



PHOTO 4: Spillway Exit Looking Downstream



PHOTO 5: Downstream Face of Dam Looking from Left Abutment.



PHOTO 6: View of Spillway from Contact Line of Natural Material Looking towards Right Abutment.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with the total rainfall depth distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The nonpeak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by utilizing the Soil Conservation Service triangle unit hydrograph using Hydrologic Soils Group "B" and Antecedent Moisture Condition III, and SCS CN 82 used to determine rainfall excess.
2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves.
3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.
4. The above methodology has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the attached computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.
5. The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option. Releases were calculated for: 1) the principal spillway and, 2) the flow over the top of the dam. These releases were then combined at each of their respective elevations.

Flow through the spillway was approximated by considering the 11'-0" by 9'-0" corrugated metal pipe as a 10'-0" diameter CMP.

Discharge rates were calculated by writing the Bernoulli equation between the lake water surface and the energy gradient elevation in the pipe at its outfall.

When the pipe is flowing at depths greater than 1/2 the diameter, this equation can be written as follows:

$$\text{Stage} = \text{I.E.} + d + L_e$$

Where: I.E. = Invert elevation at pipe entrance;

d = Depth for a given flow rate or discharge

L_e = Entrance loss, taken as $k_e \frac{(V)^2}{2g}$, with $k_e = 0.5$

Stage = Pool water surface required for a given discharge

When the pipe is flowing at depths of 1/2 the diameter or less, and flow is critical the equation can be reduced to:

$$\text{Stage} = \text{I.E.} + d_c$$

Where:

I.E. = Invert elevation of paved approach channel at upstream end (Normal Pool Elevation)

d_c = Critical depth in the approach channel for the given flow rate or discharge

Stage = Pool water surface required for the given discharge

Flow over the top of dam was calculated using the weir flow equation:

$$Q = CL(H)^{1.5}$$

where: C = Varies with head as outlined in "Handbook of Hydraulics" by Horace Williams King, revised by Ernest F. Brater.

L = Length in feet (varies with water surface)

H = Head of water in feet (varies with water surface)

Q = Discharge in cfs

FLOOD HYDROGRAPH PACKAGE (MFC-1)
NAM SAFETY VER910N JULY 1978
LAST MODIFICATION 3 AUG 78

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COMPUTER INPUT DATA

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77450 10.49.46.

PAYMORSE LAKE
OCT. 30. 1978
MO. INV. NO. 30994

JOB SPECIFICATION		JOB SPECIFICATION		JOB SPECIFICATION		JOB SPECIFICATION	
NO	MMR	MMIN	TDAY	INR	IMIN	METRC	IMPLT
298	-0	5	-0	-0	-0	-0	-0
			JODEP	MNT	LMPT	TRCF	
			5	-0	-0	-0	
							PORT
							-4
							NATAN
							-0

MHL 71-PLAN ANALYSIS TO BE PERFORMED
 NPLAN= 1 NRTIO= 6 LRTIO= 1
 25 .30 .40 .50 1.00

07105*

SUR-AREA RUNOFF COMPUTATION									
ISTAQ	ICOMP	IECON	ITYPE	JPLT	JPRY	INAME	ISTAGE	IAUTO	
INFLOW	0	-0	-0	-0	3	-0	-0	-0	

HYDROGRAPH DATA

INYNB	1	TAREA	SNAD	TRSDA	TRSP
			-0.00	.A5	1.00
IUNA	2				

PRECIP DATA

SPFF	PMS	P6	R12	R24
-0.00	26.00	100.00	120.00	130.00

LOSS DATA										
LOSS	STYRENE	DILUTED	RTIOL	FRACN	STYRENE	RTIOL	STYL	CNSTL	ALSMX	RTIOL
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-92.00	-0.00	.05

CURVE NO = -A2.00 VETNESS = -1.00 EFFECT CN = A2.00

INIT HYDROGRAPH DATA
TC= -0.00 LAG= .60

RFCESSION DATA
1-70 QRCN# -10
SYSTEM= RTTOR= 3.00

[illegible][illegible]

INPUT UNIT HYDROGRAPH

1.01	5.45	69	.01	.01	31.	1.01	17.45	213	.24	.00	1471.
1.01	5.50	70	.01	.01	32.	1.01	17.50	214	.24	.00	1459.
1.01	5.55	71	.01	.01	33.	1.01	17.55	215	.24	.00	1402.
1.01	6.00	72	.01	.01	33.	1.01	18.00	216	.24	.00	1756.
1.01	6.05	73	.01	.01	35.	1.01	18.05	217	.02	.00	1718.
1.01	6.10	74	.07	.04	38.	1.01	18.10	218	.02	.00	1482.
1.01	6.15	75	.07	.04	44.	1.01	18.15	219	.02	.00	1637.
1.01	6.20	76	.07	.04	53.	1.01	18.20	220	.02	.00	1577.
1.01	6.25	77	.07	.04	67.	1.01	18.25	221	.02	.00	1490.
1.01	6.30	78	.07	.04	84.	1.01	18.30	222	.02	.00	1374.
1.01	6.35	79	.07	.04	103.	1.01	18.35	223	.02	.00	1296.
1.01	6.40	80	.07	.04	124.	1.01	18.40	224	.02	.00	1889.
1.01	6.45	81	.07	.04	144.	1.01	18.45	225	.02	.00	943.
1.01	6.50	82	.07	.04	165.	1.01	18.50	226	.02	.00	806.
1.01	6.55	83	.07	.05	184.	1.01	18.55	227	.02	.00	683.
1.01	7.00	84	.07	.05	201.	1.01	19.00	228	.02	.00	477.
1.01	7.05	85	.07	.05	216.	1.01	19.05	229	.02	.00	514.
1.01	7.10	86	.07	.05	230.	1.01	19.10	230	.02	.00	461.
1.01	7.15	87	.07	.05	243.	1.01	19.15	231	.02	.00	413.
1.01	7.20	88	.07	.05	254.	1.01	19.20	232	.02	.00	370.
1.01	7.25	89	.07	.05	265.	1.01	19.25	233	.02	.00	331.
1.01	7.30	90	.07	.05	275.	1.01	19.30	234	.02	.00	297.
1.01	7.35	91	.07	.05	284.	1.01	19.35	235	.02	.00	266.
1.01	7.40	92	.07	.05	293.	1.01	19.40	236	.02	.00	238.
1.01	7.45	93	.07	.05	301.	1.01	19.45	237	.02	.00	214.
1.01	7.50	94	.07	.05	308.	1.01	19.50	238	.02	.00	192.
1.01	7.55	95	.07	.06	315.	1.01	19.55	239	.02	.00	182.
1.01	8.00	96	.07	.06	321.	1.01	20.00	240	.02	.00	174.
1.01	8.05	97	.07	.06	327.	1.01	20.05	241	.02	.00	168.
1.01	8.10	98	.07	.06	333.	1.01	20.10	242	.02	.00	162.
1.01	8.15	99	.07	.06	338.	1.01	20.15	243	.02	.00	158.
1.01	8.20	100	.07	.06	343.	1.01	20.20	244	.02	.00	155.
1.01	8.25	101	.07	.06	348.	1.01	20.25	245	.02	.00	152.
1.01	8.30	102	.07	.06	353.	1.01	20.30	246	.02	.00	150.
1.01	8.35	103	.07	.06	357.	1.01	20.35	247	.02	.00	148.
1.01	8.40	104	.07	.06	361.	1.01	20.40	248	.02	.00	147.
1.01	8.45	105	.07	.06	365.	1.01	20.45	249	.02	.00	145.
1.01	8.50	106	.07	.06	368.	1.01	20.50	250	.02	.00	144.
1.01	8.55	107	.07	.06	372.	1.01	20.55	251	.02	.00	143.
1.01	9.00	108	.07	.06	375.	1.01	21.00	252	.02	.00	143.
1.01	9.05	109	.07	.06	378.	1.01	21.05	253	.02	.00	142.
1.01	9.10	110	.07	.06	381.	1.01	21.10	254	.02	.00	142.
1.01	9.15	111	.07	.06	384.	1.01	21.15	255	.02	.00	142.
1.01	9.20	112	.07	.06	387.	1.01	21.20	256	.02	.00	142.
1.01	9.25	113	.07	.06	389.	1.01	21.25	257	.02	.00	142.
1.01	9.30	114	.07	.06	392.	1.01	21.30	258	.02	.00	142.
1.01	9.35	115	.07	.06	394.	1.01	21.35	259	.02	.00	142.
1.01	9.40	116	.07	.06	396.	1.01	21.40	260	.02	.00	142.
1.01	9.45	117	.07	.06	398.	1.01	21.45	261	.02	.00	142.
1.01	9.50	118	.07	.06	400.	1.01	21.50	262	.02	.00	142.
1.01	9.55	119	.07	.06	402.	1.01	21.55	263	.02	.00	142.
1.01	10.00	120	.07	.06	404.	1.01	22.00	264	.02	.00	142.
1.01	10.05	121	.07	.06	406.	1.01	22.05	265	.02	.00	142.
1.01	10.10	122	.07	.06	408.	1.01	22.10	266	.02	.00	142.
1.01	10.15	123	.07	.06	409.	1.01	22.15	267	.02	.00	142.
1.01	10.20	124	.07	.06	411.	1.01	22.20	268	.02	.00	142.
1.01	10.25	125	.07	.06	413.	1.01	22.25	269	.02	.00	142.
1.01	10.30	126	.07	.06	414.	1.01	22.30	270	.02	.00	142.
1.01	10.35	127	.07	.06	416.	1.01	22.35	271	.02	.00	142.
1.01	10.40	128	.07	.07	417.	1.01	22.40	272	.02	.00	142.
1.01	10.45	129	.07	.07	418.	1.01	22.45	273	.02	.00	142.
1.01	10.50	130	.07	.07	420.	1.01	22.50	274	.02	.00	142.
1.01	10.55	131	.07	.07	421.	1.01	22.55	275	.02	.00	142.
1.01	11.00	132	.07	.07	422.	1.01	23.00	276	.02	.00	142.
1.01	11.05	133	.07	.07	423.	1.01	23.05	277	.02	.00	142.

INPUT UNIT HYDROGRAPH

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 802.95 0. 0.	SPTLLWAY CRFST 802.95 0. 0.	TOP OF DAM 809.50 189. 622.	DURATION OVER TOP HOURS	MAXIMUM OUTFLOW CFS	MAXIMUM STORAGE AC-FT	MAXIMUM DEPTH OVER DAM	TIME OF MAX OUTFLOW HOURS	TIME OF FATLURF HOURS
.20	807.19					0.00	463.	140.	0.00	17.25	0.00
.25	807.97					0.00	572.	169.	0.00	17.25	0.00
.30	808.76					.26	679.	200.	1.83	17.33	0.00
.40	809.57					1.07	1455.	233.	3.00	16.67	0.00
.50	809.94					1.44	2387.	248.	3.50	16.42	0.00
1.00	811.13					2.63	5133.	300.	6.00	16.33	0.00

COMPUTER SUMMARY ANALYSIS